The Automatic Furnace – New

Application Control Number 10/765,637

Title of the Invention -

The Automatic Furnace -

System and method for

automatically maintaining

a multiburner furnace.

Inventor - Adolph Mondry

25406 Goddard Road

Taylor, Michigan, 48180

(313) 291-5550

Citizenship – United States of America

CROSS REFERENCES TO RELATED APPLICATIONS

001 Adolph Mondry – System and method for automatically maintaining a blood oxygenation level. P.N. 5,682,877, November 4, 1997 – herein referred to as 877. The flow charts of that device are similar to those of the Voltage Dosimeter.

002 Adolph Mondry – The Voltage Dosimeter – System and method for supplying variable voltage to an electric circuit. P. N. application number not yet available. The flow charts of that device are identical to that of the Automatic Furnace.

003 Lawrence E Bolo et al – Combustion in a multiburner furnace with selective oxygen flow. P.N. application Kind Code A1 20030091948, May 15, 2003. Describes multiburner furnace technology.

004 Ahrmad Al-Halbouni – Method and apparatus for providing low level N sub ox and CO combustion. PN 6,419,480 B2, July 16, 2002. Describes furnace specification without automatic feedback

as is seen in the Automatic Furnace. It does not determine a

circulation time delay.

FEDERALLY SPONSORED RESEARCH GRANTS

004 There are no Federally sponsored research grants available to those involved in the research and development of this device.

BACKGROUND OF THIS INVENTION

005Multiburner Furnaces provide heat and energy. With recent improvements in furnace design the ratio of combustants to oxidants yield lower levels of flue carbon monoxide (CO) in a less fuel rich burn producing less ash and greater efficiency; less flue nitrogen monoxide (NO) in a fuel lean burn, producing less pollution; and, flue temperature balancing decreasing CO and increasing NO. Day to day use may undo these improvements at a cost. It is desirable to have a device available, which automatically controls and prolongs these improvements.

BRIEF SUMMARY OF THE INVENTION

006 It is an object of the present invention to provide a method to control CO, NO, or temperature <u>as byproducts</u> in the flue of a multiburner furnace <u>by</u> deliver<u>ing</u> appropriate oxidants to the combustants at the burners <u>of a multiburner furnace</u> to increase efficiency and decrease pollution. It is a further object of this invention to provide a <u>method</u> which will prolong all improvements.

007 In carrying out the above objects and other stated objects and features of the present invention a method is provided as an Automatic Furnace for maintaining a desired CO <u>concentration,</u> NO <u>concentration,</u> or temperature range at the flue (referred to as flue parameters) of a multiburner furnace and includes delivering <u>the largest</u> oxidant (oxygen or air) (delete dose) <u>flow rate</u> to the combustant/oxidants at the burners of a multiburner furnace of any design producing flue parameter dose<u>s</u> from one of a plurality of flue parameter doses between <u>the smallest and largest</u> flue parameter dose. The method includes delivering <u>continuously</u> the largest oxidant (delete dose) <u>flow rate</u> while repeatedly sequencing through the plurality of sequential flue parameter <u>concentrations</u> (delete doses)

beginning with the smallest flue parameter (delete dose) concentration

and proceeding to an adjacent flue parameter (delete dose)

concentration in the sequence after a predetermined time interval has

elapsed. The largest oxidant (delete dosage) flow rate is delivered

continuously until the flue parameter (delete level) concentration

attains the desirable range, at which point a corresponding oxidant

flow rate (delete dose) is selected from the plurality of sequential

oxidant (delete doses) flow rates. The method also includes delivering

continuously the selected oxidant (delete dose) flow rate so as to

maintain the desired flue parameter concentration range.

008 In the preferred embodiment the method employs CO as the

sole flue parameter. Other flue parameters may be employed as

well.

009 The advantages of the Automatic Furnace are minimal needs

for furnace shut downs, less pollution, more efficiency, and a

reduction in the cost of running and maintaining a multiburner

furnace.

010 The above objects, features, and other advantages will be

readily appreciated by one of ordinary skill in the art from the

following detailed description of the best mode for carrying out the

invention, when taken in connection with the accompanying

drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

011 Fig. **1/6** demonstrates a perspective view of the first embodiment of the present invention.

012 Fig. **2/6** is a graphical demonstration of the flow charts of the Automatic Furnace.

013 Fig. **3/3-5/6** are flow charts dealing with the oxidant (delete dosage) flow rate and CO level and dosage strategy of the present invention for use in the Automatic Furnace.

014 Fig. **6/6** is a flow chart for relating parameters in the Automatic Furnace.

DETAILED DESCRIPTION OF THE INVENTION

015 Referring now to Fig. **1/6**, a first embodiment of the present invention <u>is</u> (delete are) shown. This embodiment indicated by reference number **1** in Fig. **1/6** is the best mode in implementing this invention and is particularly suited for use as an Automatic Furnace. Figure **1/6** includes **2,** multiburners; **3,** combustants (solid, liquid, or gas): **4,** oxidants (oxygen or air); **5,** a furnace flue; **6,** flue gases; **7,** a flue parameter sensor in Vol% or degree Centigrade; **8,** a band pass filter<u>, which is unique for an Automatic Furnace</u>; **9,** the ECU<u>, which is unique for an Automatic furnace</u>; **10,** a variably opening solenoid valve,<u> which is unique for an Automatic Furnace</u>; and, **11,** the oxidant entrance.

016 In response to flue parameter sensor **7** data, oxidant flow rates at the inlets (delete "s") **11** are controlled by an ECU **9** controlled variably opening solenoid valve **10** with Coulomb controlling circuits, as was taught in 877 and United States P. N. 5,008,773. They enhance or restrict combustion at the burners **2**.

017 Referring now to Fig. **2/6**, the method of device function is demonstrated graphically. The flue parameters (delete the terminal

10

"s") concentration is (delete are) placed on the ordinate and time (delete or) and oxidant flow rate (delete dosage) are placed on the abscissa of a Cartesian plane. Maximum or minimum oxidant dosage occurs at tr on the abscissa, the significance of which will be presented later). Measured or (delete and) calculated logarithmic functions are used in the preferred embodiment as flue parameter dosages, but any measured and estimated transcendental function with an inverse may be used. Maximum or minimum flue parameter (delete doses) concentrations occur at tr on the abscissa, the significance of which will be presented later.

018 Referring again to Fig. **1/6**, as will be seen, conditions on CO – the preferred flue parameter - control oxidant flow rate **11** and thus CO concentration and dosage.

019 Referring now to Fig. **2/6**, the illustrated method of oxidant flow rate (delete dosage) and CO concentration and dose (delete range) selection starts with the administration of (delete an extreme) the largest reactive oxidant gas flow rate – herein referred to as the selector dose of the oxidant gas flow rate which produces the maximum (delete or minimum) CO dosage – as in curve A

11

(delete or B). Curve A is represented by y=log to the base a of x. Curve A activates at x=0.

020 Line CG is the desired CO <u>concentration</u> level – herein referred to as the selection parameter, which is a range in the actual device. At the intersection of line CG and curve A (delete or B) (call it X), line D points to point E on the abscissa as the selected oxidant <u>flow</u> rate (delete dose). This is determined by graphical means and, as will be seen, the flow charts. <u>Curve B is the minimum CO dosage. Which curve is used depends on the initial proximity to line CG.</u> The virtual CO dosage in Vol % is curve F, which activates at point E, the selected oxidant flow rate, and is boosted by curves A, B, H – an overshoot of curve A – and curve I – a deactivation of curve H – to produce line G, which is the selected CO concentration level (delete ",") <u>and</u> is also a CO dosage, and is represented by y=log to the base b of tr, where tr is the t value of the flattening out of the logarithm y=log to the base b of t (curve F) at tr seconds <u>by line G.</u> Line G is completely determined by the intersection (X) described above and in the flow charts, as will be seen, thus the determination of line G and curve F by the above method is unnecessary. Curve F and line G start in the

12

x coordinate system at x=t and in the t coordinate system at t=0, when curve A or B deactivates. Curve F and line G deactivate when curve A or B activates. Curve J is the virtual curve of curves A and H. K marks the Circulation time. It marks the time from the initial maximum oxidant gas flow rate to the first recording of any change in the CO concentration (delete dosage). Its accuracy is essential for proper flow chart function with respect to time. Its calculation and that of tr will be demonstrated. The oxidant flow rate (delete dose) and CO concentration are circulation time dependent.

021 Before describing the flow charts it is useful to explain the terminology employed. The most recent base state keeps the CO concentration in its desirable range. The oxidant flow rate and CO concentration level are measured in all states. The washout state washes out overshoots. It also determines the selected CO concentration level (delete and dose) and the oxidant flow rate, as will be seen. CO concentrations and doses are functions of oxidant flow rates.

022 Referring now to Fig. **3/6-5/6**, flow charts are shown, which illustrate the system and method for the proper selection of oxidant flow rates and CO concentrations and doses.

023 Referring to Fig. **3/6,** Step **400** determines various system parameters, which may be predetermined and stored in memory, calculated by an ECU (such as ECU **9** in Fig. **1/6)** or entered by a system operator. The system parameters include the following:

Dosage=the plotted function in the Cartesian plane.of flue parameter concentration as a function of oxidant flow rates.

MIN R=minimum dose of (delete oxidant flow rate) CO concentration as a function of oxidant flow rate given for each range.

MAX R=maximum dose of (delete oxidant flow rate) CO concentration as a function of oxidant flow rate given for each range.

CO=Flue parameter (delete level) concentration in Vol%

Tv1=desired CO concentration level.

dL=low CO concentration level threshold.

dH=high CO concentration level threshold.

TSS=series state delay time.

Tcirc=circulation delay time.

Twash=washout delay time.

tr=desired response time or reaction time – the t value at dose selection.

Range=a flow sheet with a specific number of increment durations.

IR=number of increments per range.

The value of dH and dL are determined by the current operating state.

024 As shown in Figure **3/6** the ECU now passes control to Step **402**, which measures the oxidant flow rate and CO <u>concentration</u> level. At Step **404** a maximum oxidant <u>flow rate </u>of the last range is administered, <u>producing a maximum CO concentration dose</u>. This is represented graphically by curve A of Figure **2/6** and is called the selector dose. (Delete "It represents the extreme maximum oxidant dose.") The possible CO concentration dose is set for the lowest level of the lowest range.

025 With continuing reference to Figure **3/6** at Step **406** the oxidant dose is maintained while pausing Tcirc seconds, then x is set to 0 seconds. Step **406** is called an adjustment state. It coordinates the flow charts with respect to time. Initial circulation times may be estimated or measured.

026 Referring once again to Figure **3/6** the ECU passes control to Step **408**, which continues to deliver the maximum oxidant (delete dosage) flow rate to the burners. Step **408** is referred to as a series state -Tss – and is necessary to coordinate the progression through various possible CO levels within a time period determined by tr. The calculation of Tss depends on the current operating state. Some representative calculations are illustrated in Figure **6/6** for a single ranged implementation as discussed in greater detail below.

027 Still referring to Figure **3/6** a test is performed at Steps **409** and **410**. It asks – is the CO concentration greater than dH? – and, is the CO concentration less than dL?, respectively. They split control into three pathways. Negative answers to both conditions direct control to Step **426**, where 1. The (delete current) CO concentration level is set to the possible level, while the oxidant flow rate (delete dose) is selected. 2. A pause for the circulation time of zero takes place. Then, 3. t is set to 0. This represents oxidant (delete dose) flow rate and CO concentration selection.

028 Now referring to Figure **4/6** processing continues with the ECU directing control to Step **428**, which pauses to washout high valued functions from the desired CO dose. The state is completed

when all involved functions equal a straight horizontal line – the

desired CO concentration, which is a range in the actual device.

The CO dose is pictured as curve A or B in Figure **2/6** as maximum

or minimum doses, but all doses in between are possible. Both of

the above dosages continue until activation of MIN R or MAX R.

Step **430** measures CO concentration values for the Conditions

below. Steps **432** and **433** represent a second test and ask the same

questions as the above mentioned first test – Is the CO

concentration greater than dH or less than dL, respectively? If

either answer yes, control is directed to Steps **431** and **434,**

respectively, where a predetermined fraction of tr is either

subtracted or added, respectively to tr. This pathway determines tr

only if the circulation time is correct. The circulation time is

calculated by keeping the last three base state values in memory.

When control is directed to or beyond a noncontiguous base state

from which control was originally assumed a predetermined

amount of time is added to the circulation time. This will correct

abnormally short circulation times. For abnormally long circulation

times – if control passes consecutively to two ascending or

descending base states, a predetermined amount of time is subtracted from the circulation time.

029 Referring now to Figure **5/6,** if both conditions in the second test answer no, the ECU places control in Step **436**, the base state. Steps **438** and **440** represent the third test and ask the same questions (is CO > dH or < dL?) as those of the previous tests with different consequences. They determine the stability of the base state (both conditions answer no if it is stable). If it is unstable, the ECU directs control to either Step **463,** if Step **438** answers yes, or **446,** which 1. Minimizes or maximizes the <u>oxidant flow rate and consequential CO concentration</u> dose, respectively 2. Pauses for the circulation time, then 3. sets x=0. These doses continue until dose selection. It should be noted that Steps **431, 434,** the yes part of **418,** and the no part of Steps **433** and **440** all yield control to Step **436**, the <u>stable</u> base state. The ECU then directs control from Step **463** to Step **411,** and from Step **446** to Step **412**.

030 Referring again to Figure **3/6,** the ECU directs control from Step **464** (evaluated later), and if Step **414** in Figure **4/6** (the first condition of fourth test to be elucidated soon) answers no, to Step **408** to maintain the current CO <u>concentration</u> dose for Tss. Control

is then directed to Step **409**, which, if along with Step **410** - the first test – the answer is yes to both conditions, control is passed to Steps **411** and **412**, respectively, which decrement and increment the possible CO concentration dose, respectively, then both pass control to Condition **414**.

031 Referring now to Figure **4/6**, Steps **414** and **418** represent the fourth and final test with different conditions than the other tests. These conditions ask if the present possible CO concentration dose is the last dose available, and if the present range is the last one available, respectively. If Step **414** answers no, control is directed by the ECU to Step **408** in Figure **3/6**, which maintains a current dose for Tss. If the condition answers yes, control is directed to Step **418**, which determines if the present range is the last range available. If it answers no, control is directed to Step **464**, in which control enters a new range, sets the (delete current)exit voltage and voltage producing) oxidant flow rate and flu parameter doses to MAX R or MIN R of the new range, pauses for the circulation time, then sets x=0. Control is then directed to Step **408**, which maintains a current CO concentration dose for Tss. If Step **418** answers yes, the ECU directs control to Step **436**, the base state.

032 Referring now to Figure **6/6** a flow chart is shown illustrating representative calculations of Tss according to the present invention. One of these calculations or an analogous calculation is performed for each series state of Figure **3/6-5/6**, such as illustrated at Steps **408, 411,** and **412**.

033 Returning to Figure **6/6** at Step **480** a test is performed to determine if the system has reached a base state. If not, the series state delay is estimated as: Tss=tr/IR. If the result is true, the process continues with Step **484**, where a test is performed to determine whether (delete v2) <u>the flue parameter concentration</u> <u>is</u><dL. If true, then Step **486** determines whether the most recent base state is a minimum for the current range. If it is true, the series state delay is calculated by Step **488** as Tss=tr/(IR-1). Step **498** then returns control to the series state which initiated the calculation.

034 With continuing reference to Figure **6/6,** if the test at Step **486** is true, then the series state delay is calculated by Step **490** as Tss=tr(MAX R-MIN R)/(IR-1)(MAX R-BASE STATE) before control is released to the series state via Step **498.** If the test performed at Step **484** is false, then Step **492** performs a test to determine if the most recent base state is the maximum for the

current range. If the result of Step **492** is true, then Step **496**

calculates the series state delay as Tss=tr/(IR-1). Control is then

returned to the appropriate series state via Step **498.** If the result of

the test at Step **492** is false, then the series state delay is calculated

by Step **494** as Tss=tr(MAX R-MIN R)/(IR-1)(BASE STATE-MIN

R). Step **498** then returns control to the appropriate series state.

Figure **6/6** applies to a single range. One of ordinary skill in the art

should appreciate that the calculations may be modified to

accommodate a number of possible ranges.

035 It should be apparent to any one skilled in the art that the

flow charts provide a method for an Automatic Furnace.